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Tu et al.

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(54) **ESCAPEMENT DEVICE FOR TIMEPIECE**

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Jul. 6, 2000 (CH) 1332/2000

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(52) **U.S. Cl.** **368/126**; 368/127; 368/160

(58) **Field of Search** 368/124–133, 368/160–164

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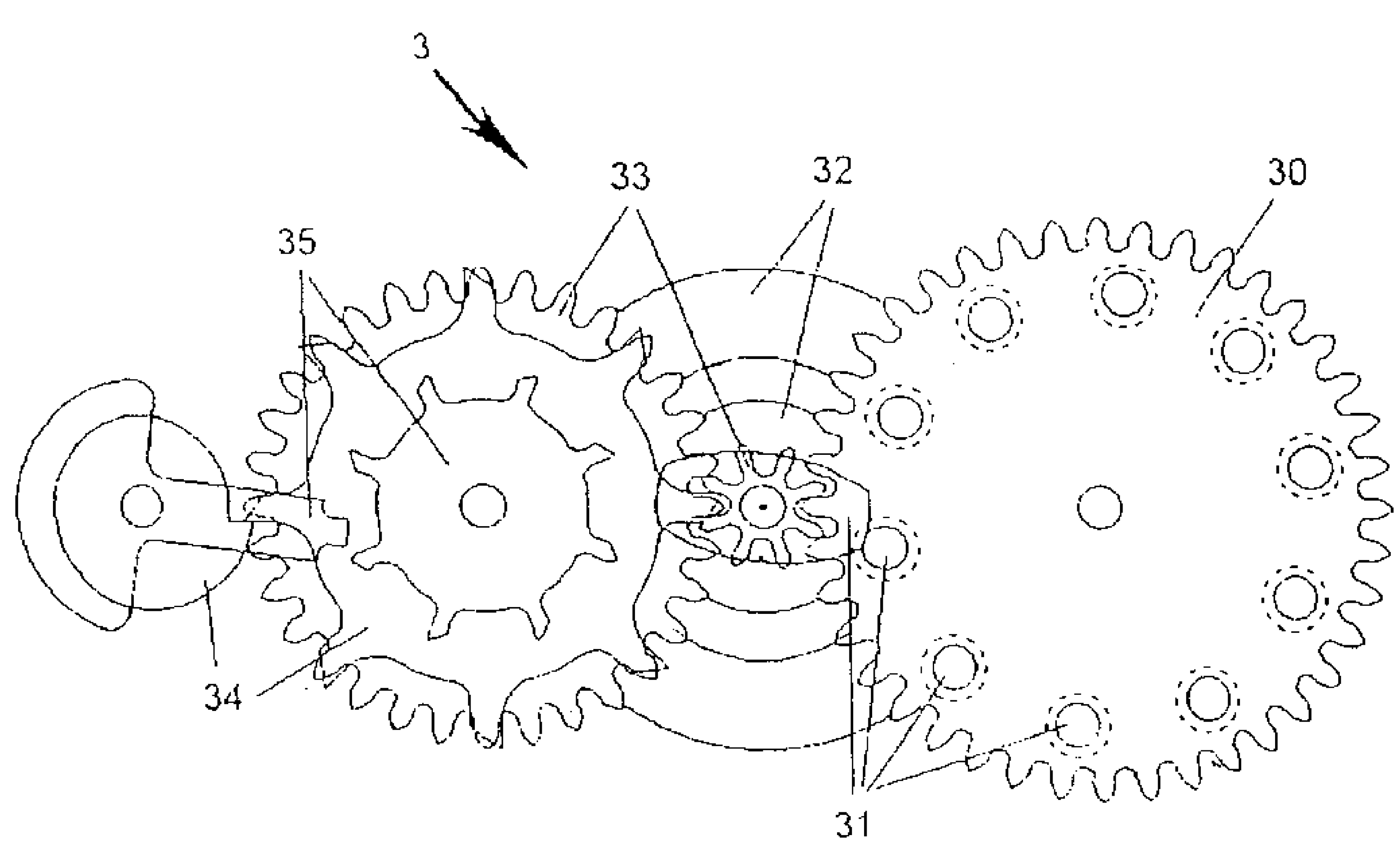
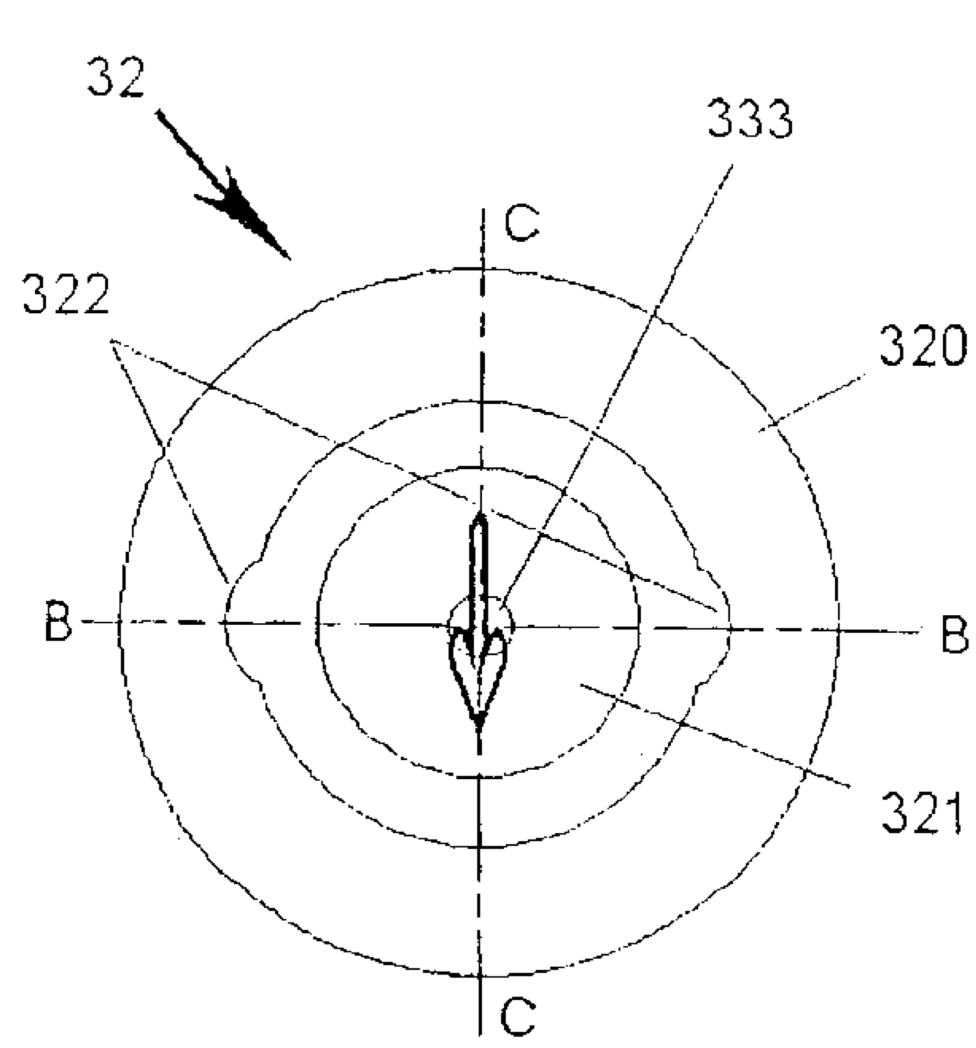
(74) *Attorney, Agent, or Firm*—Pearne & Gordon LLP

(57) **ABSTRACT**

The invention concerns an escapement device comprising a power source capable of delivering a variable torque based on the angle of rotation of a pinion fixed to said power source, said variable torque having at least a stable position and an unstable position. The device further comprises locking means capable of locking power transmission to an oscillator in a stable point of equilibrium and unlocking means capable of unlocking power transmission to said oscillator between a stable point of equilibrium and an unstable point of equilibrium.

19 Claims, 8 Drawing Sheets





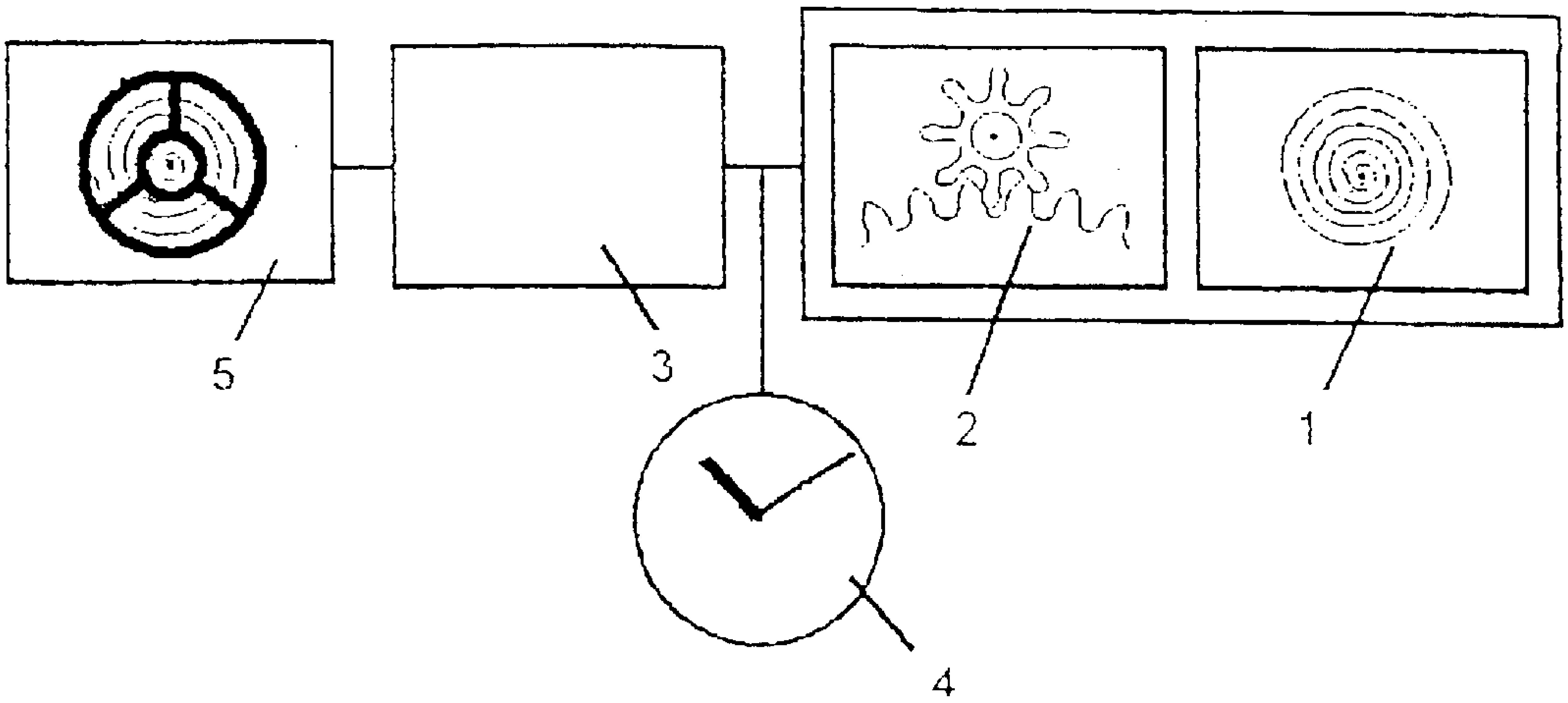


Fig 1

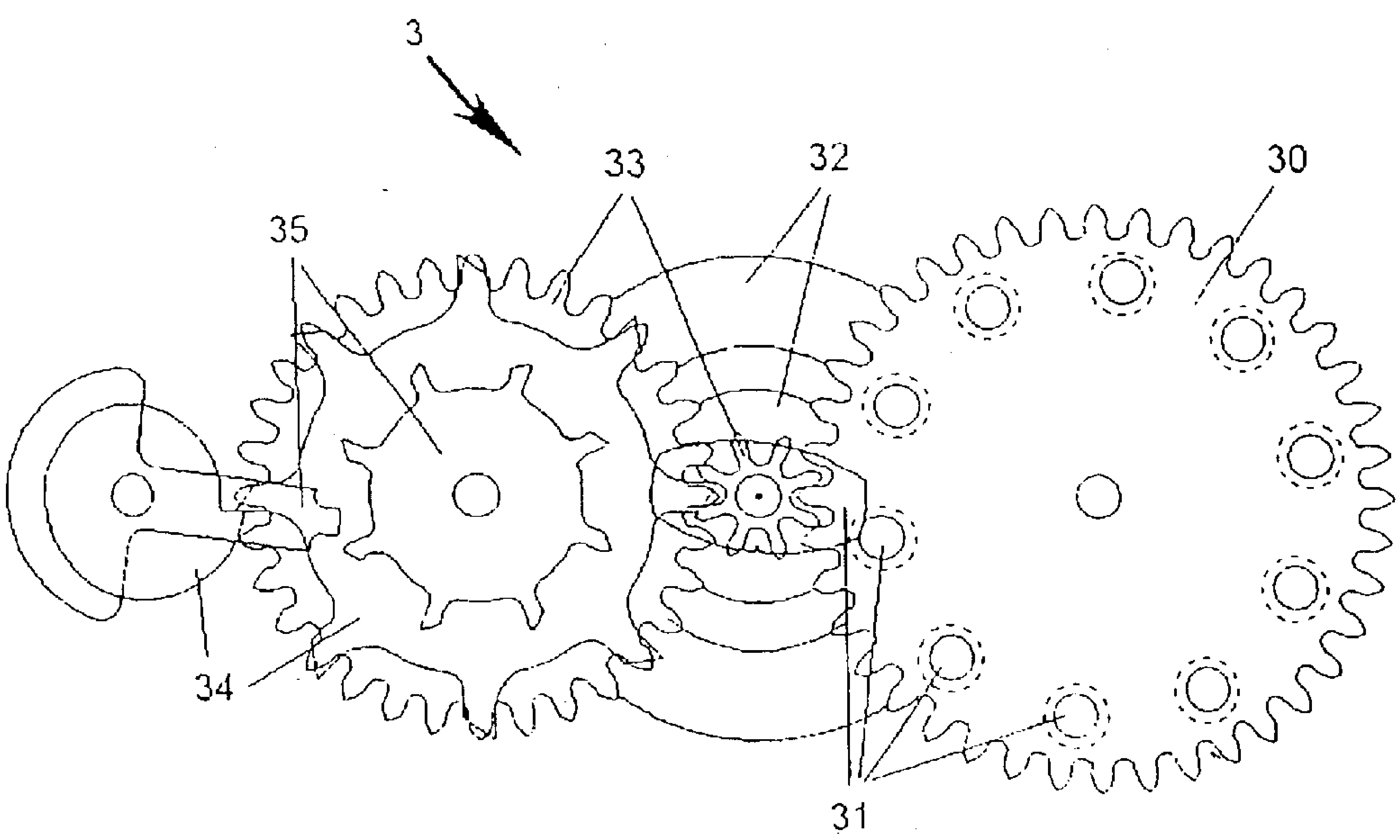


Fig 2

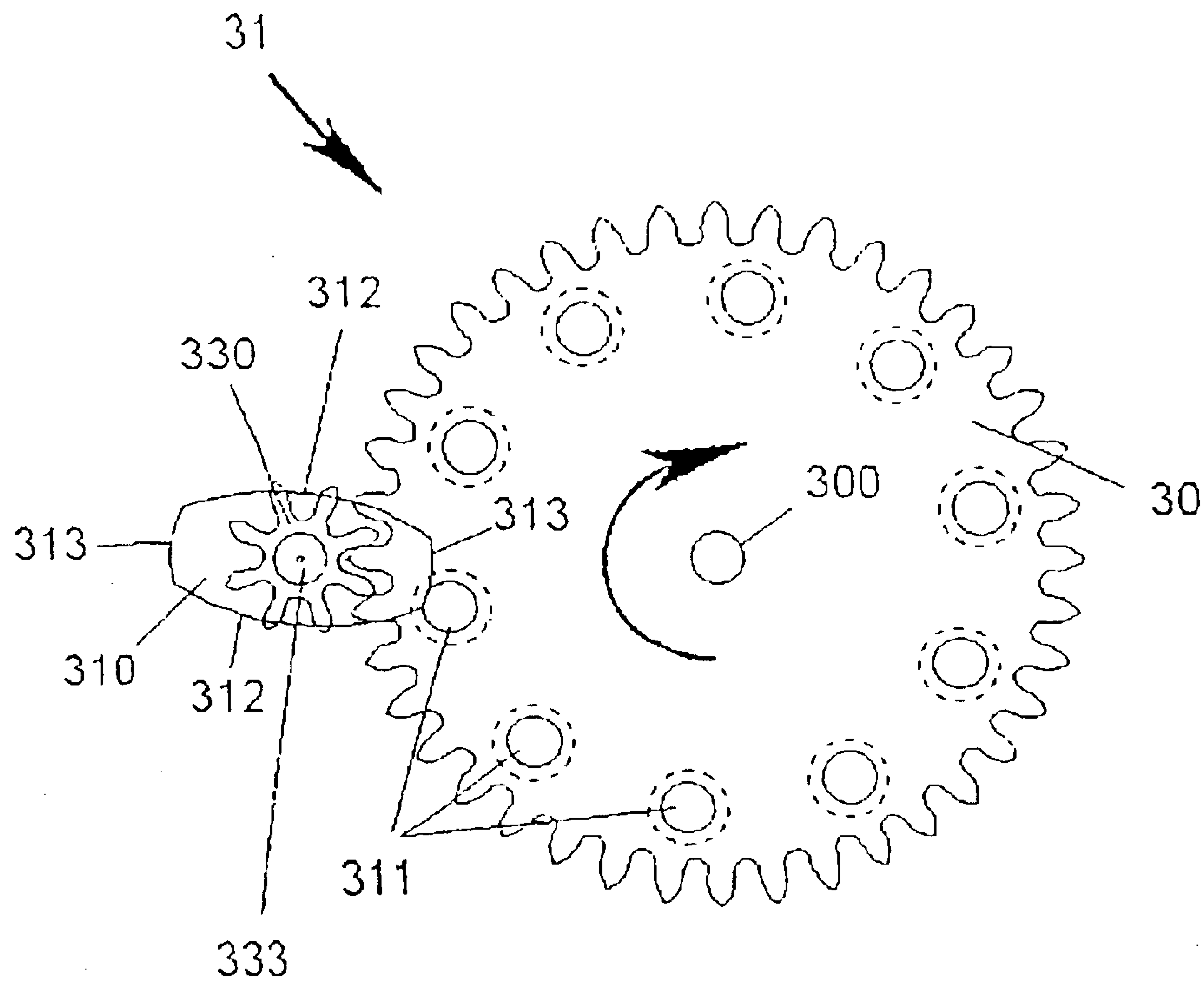

31
312
330
313
313
300
30
310
312
311
333

Fig 3

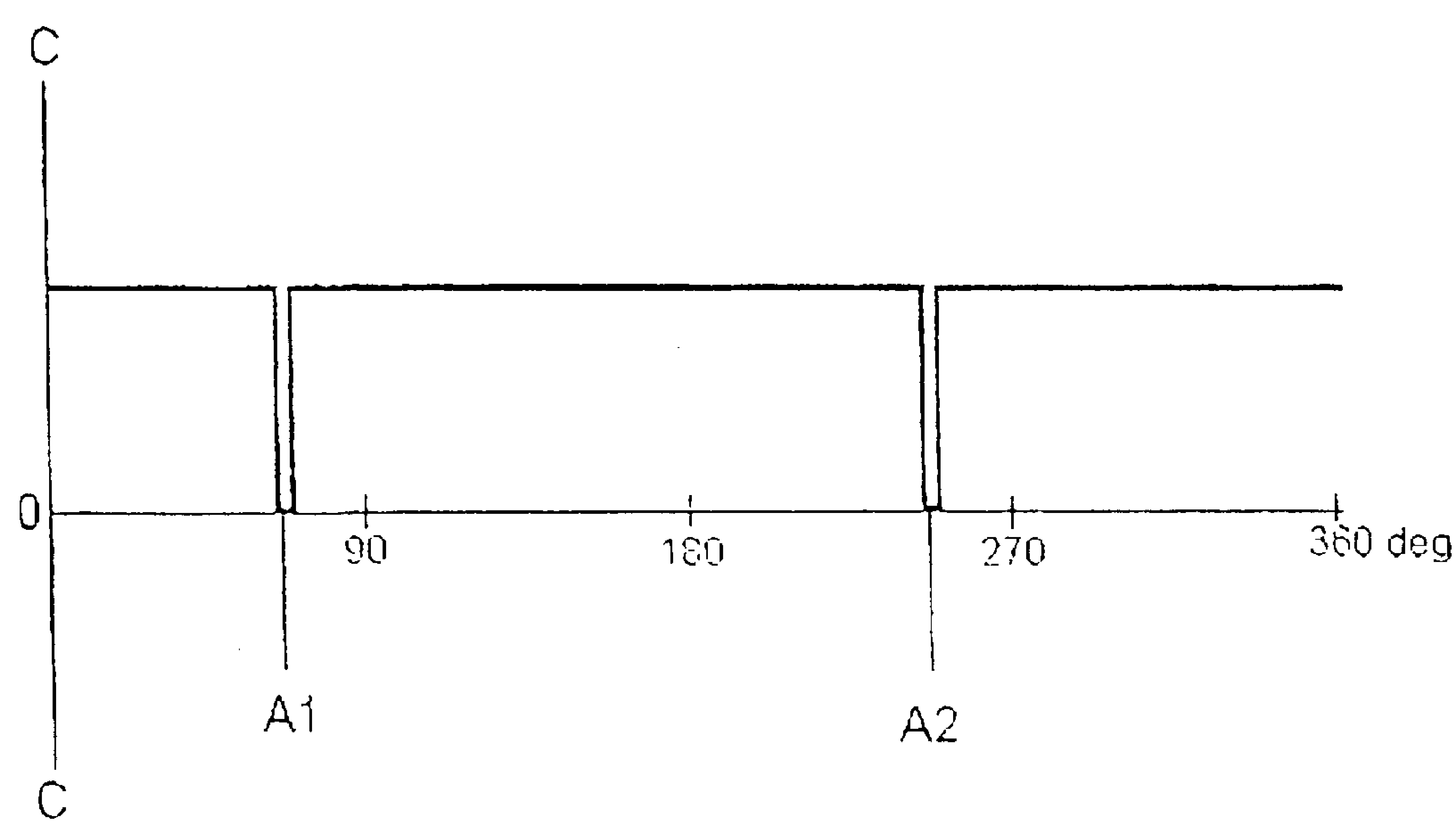

C
0
90
180
270
360 deg.
A1
A2
C

Fig 4

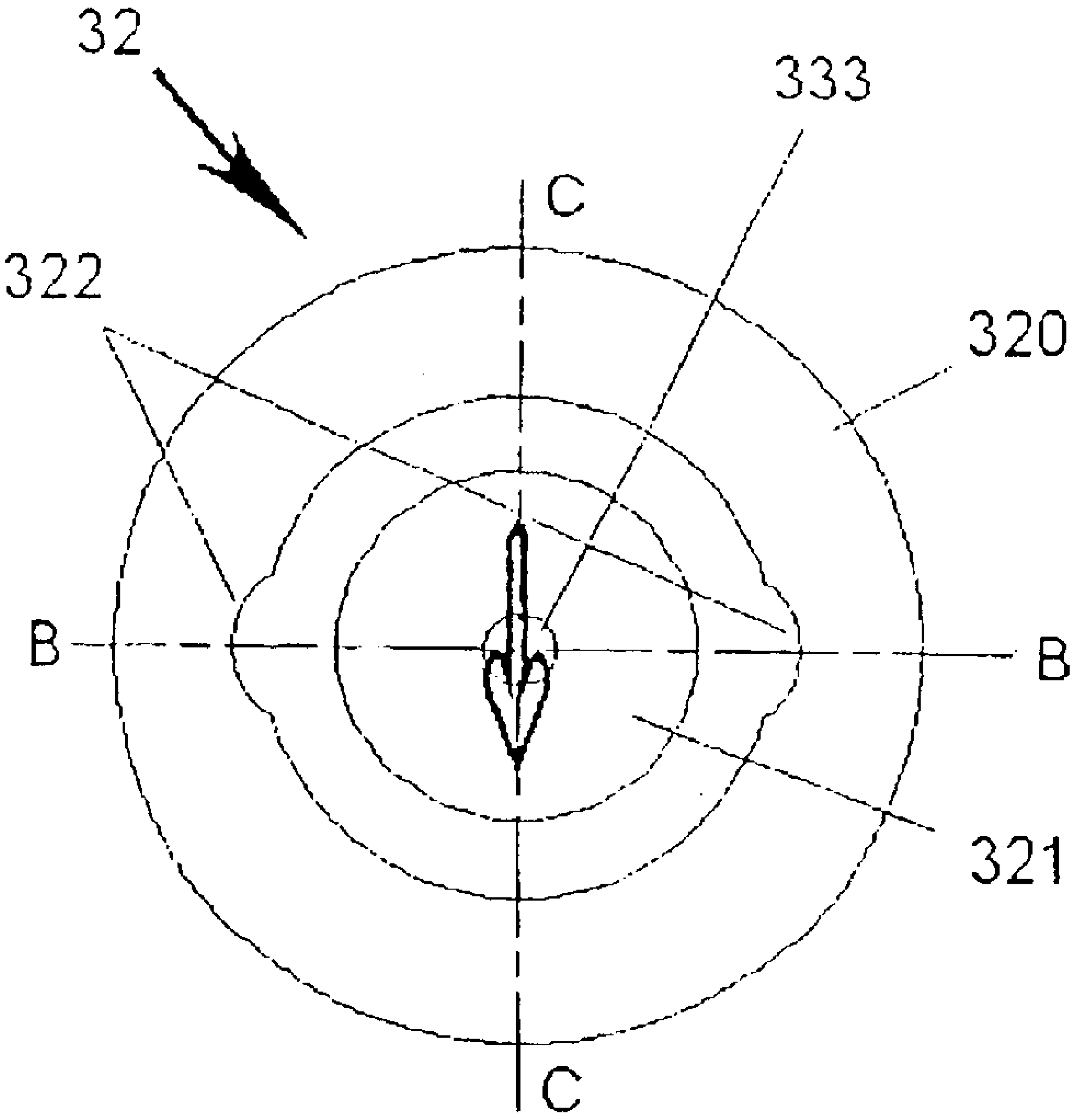


Fig 5

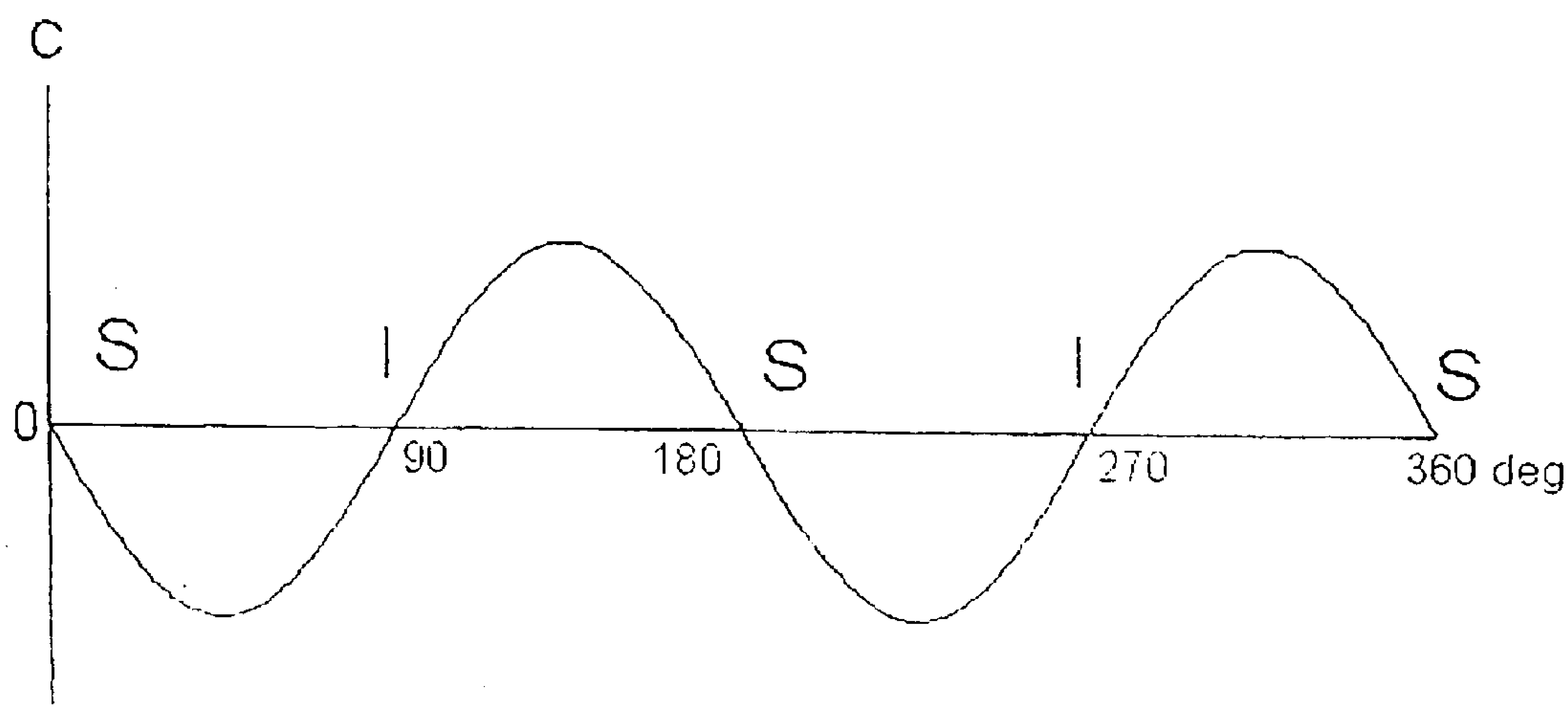


Fig 6

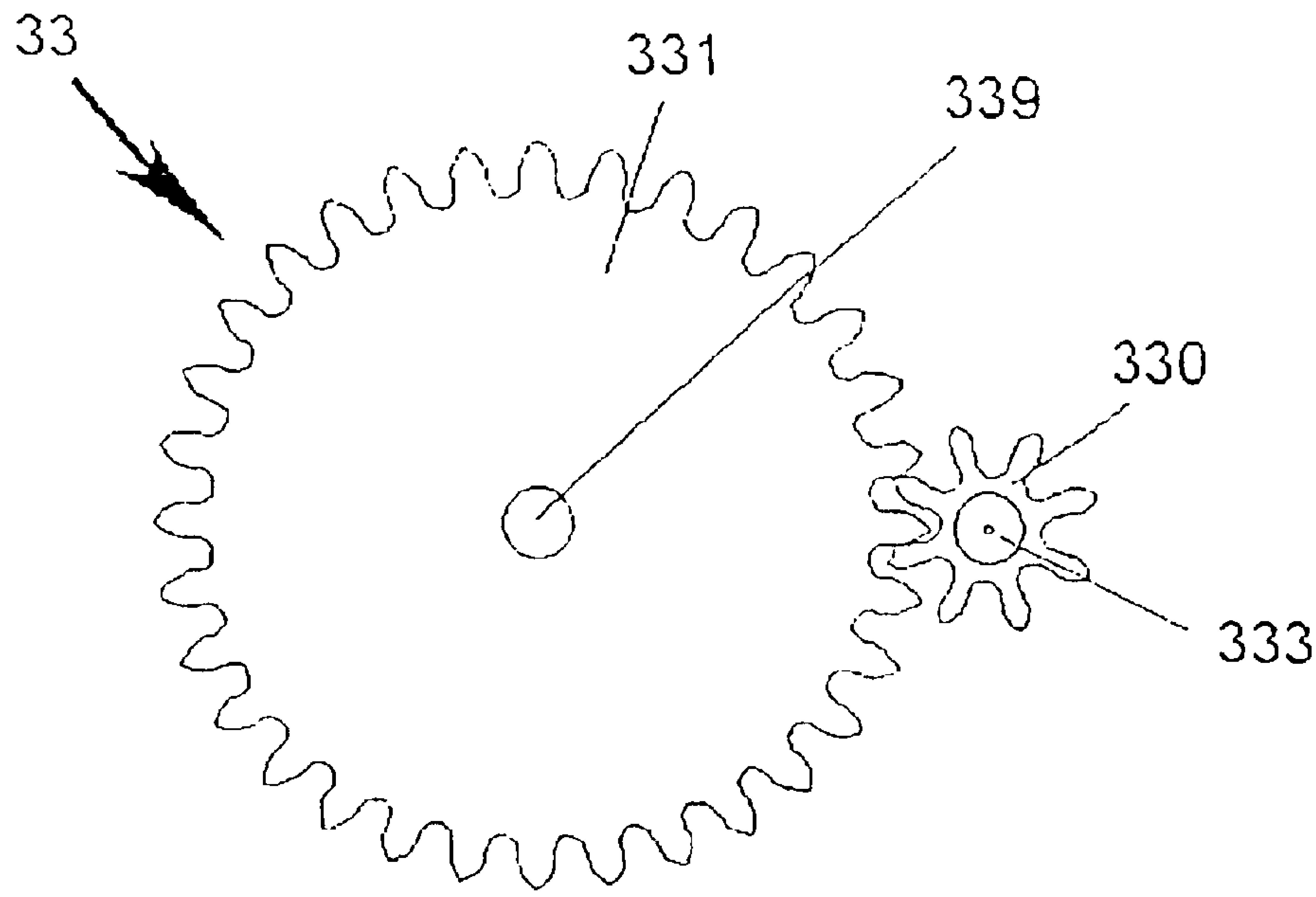


Fig 7

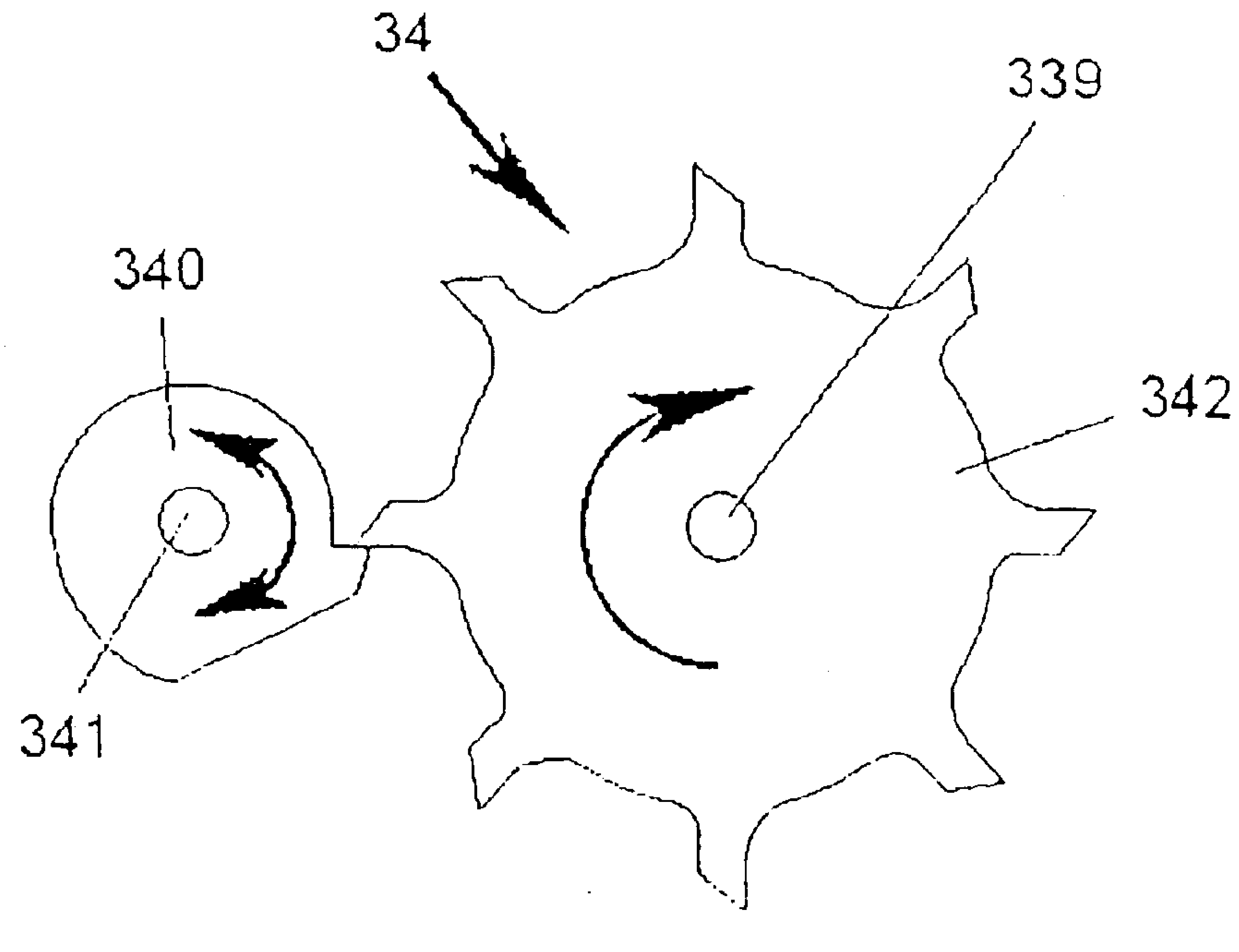


Fig 8

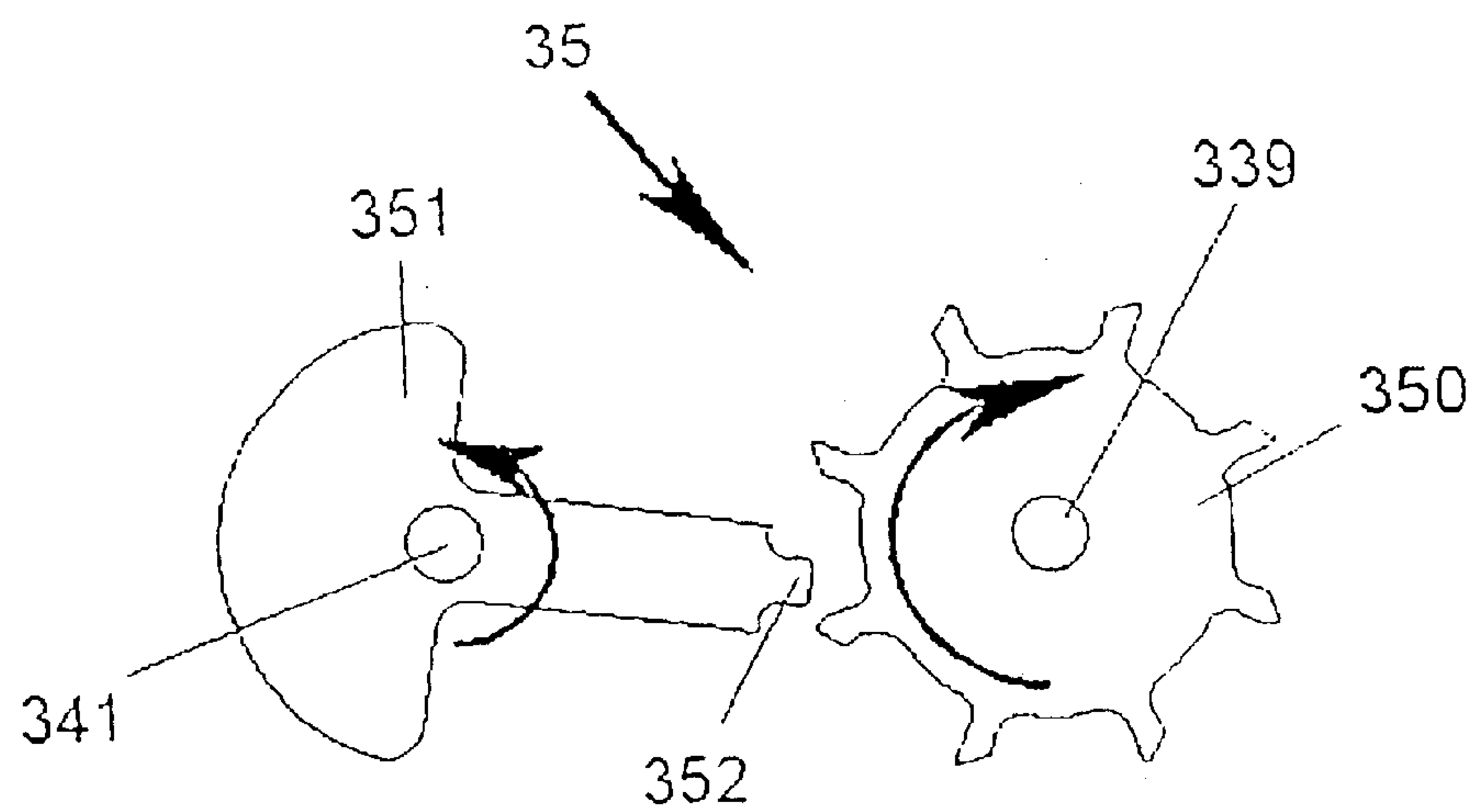


Fig 9

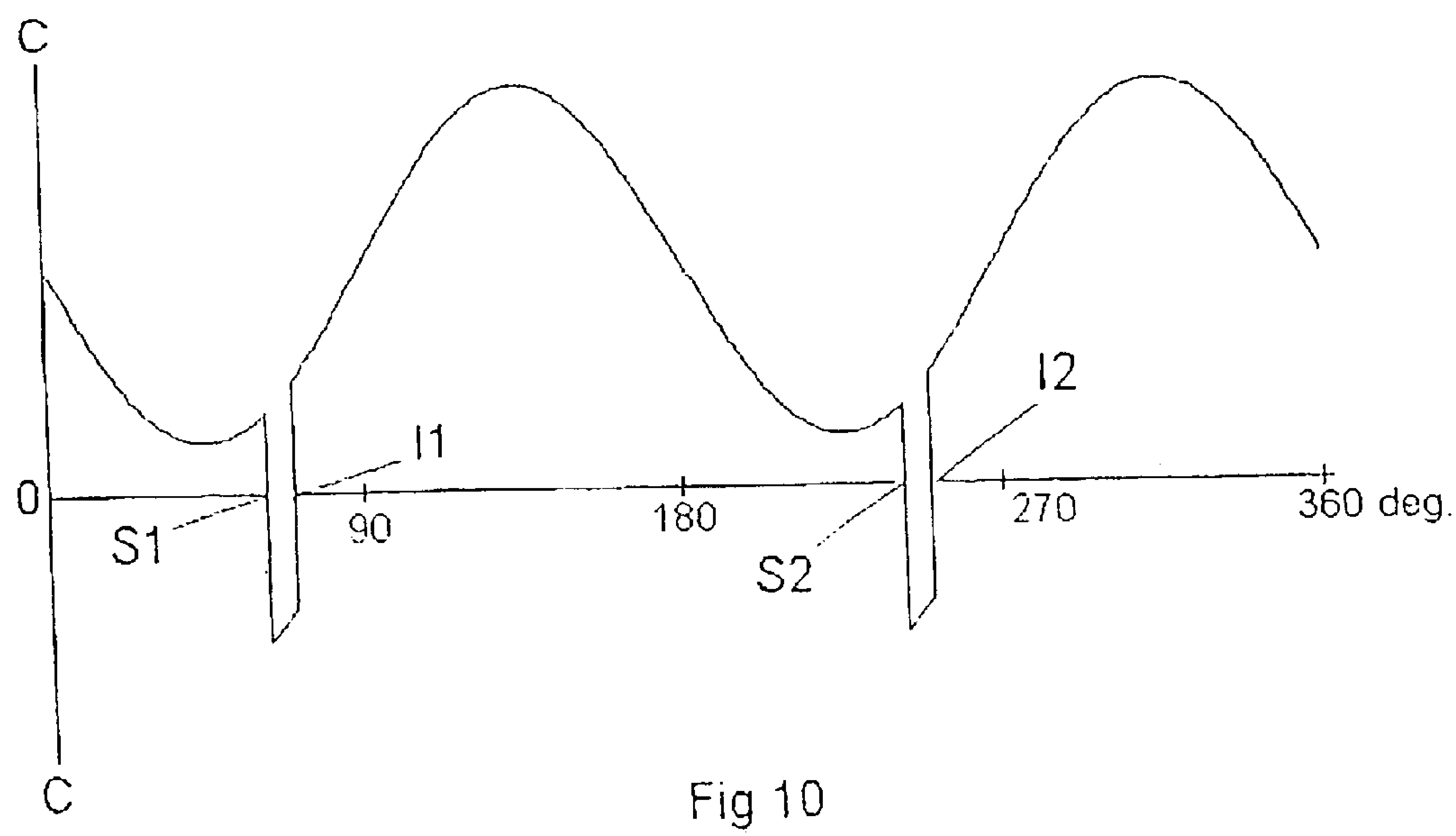


Fig 10

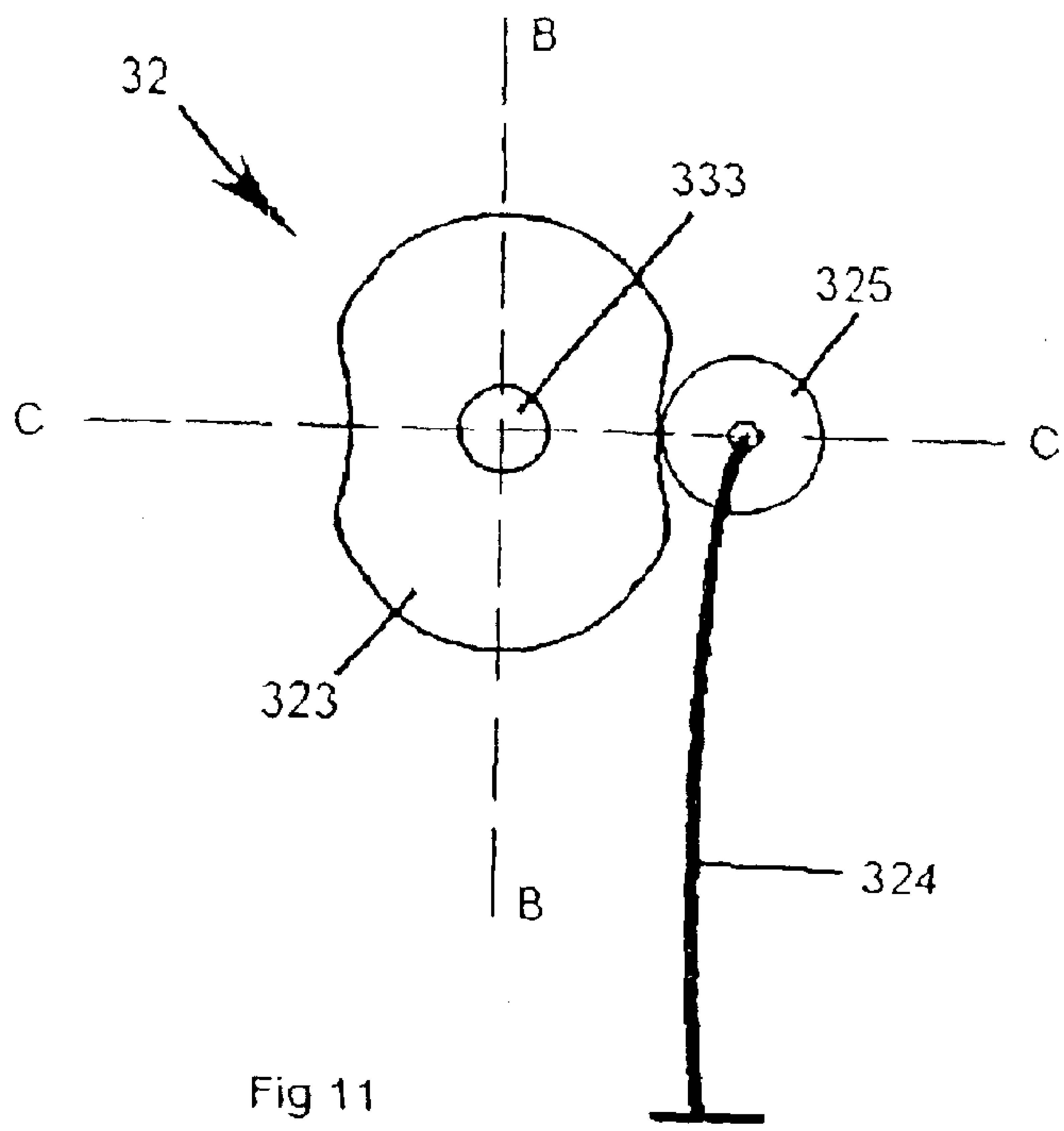


Fig 11

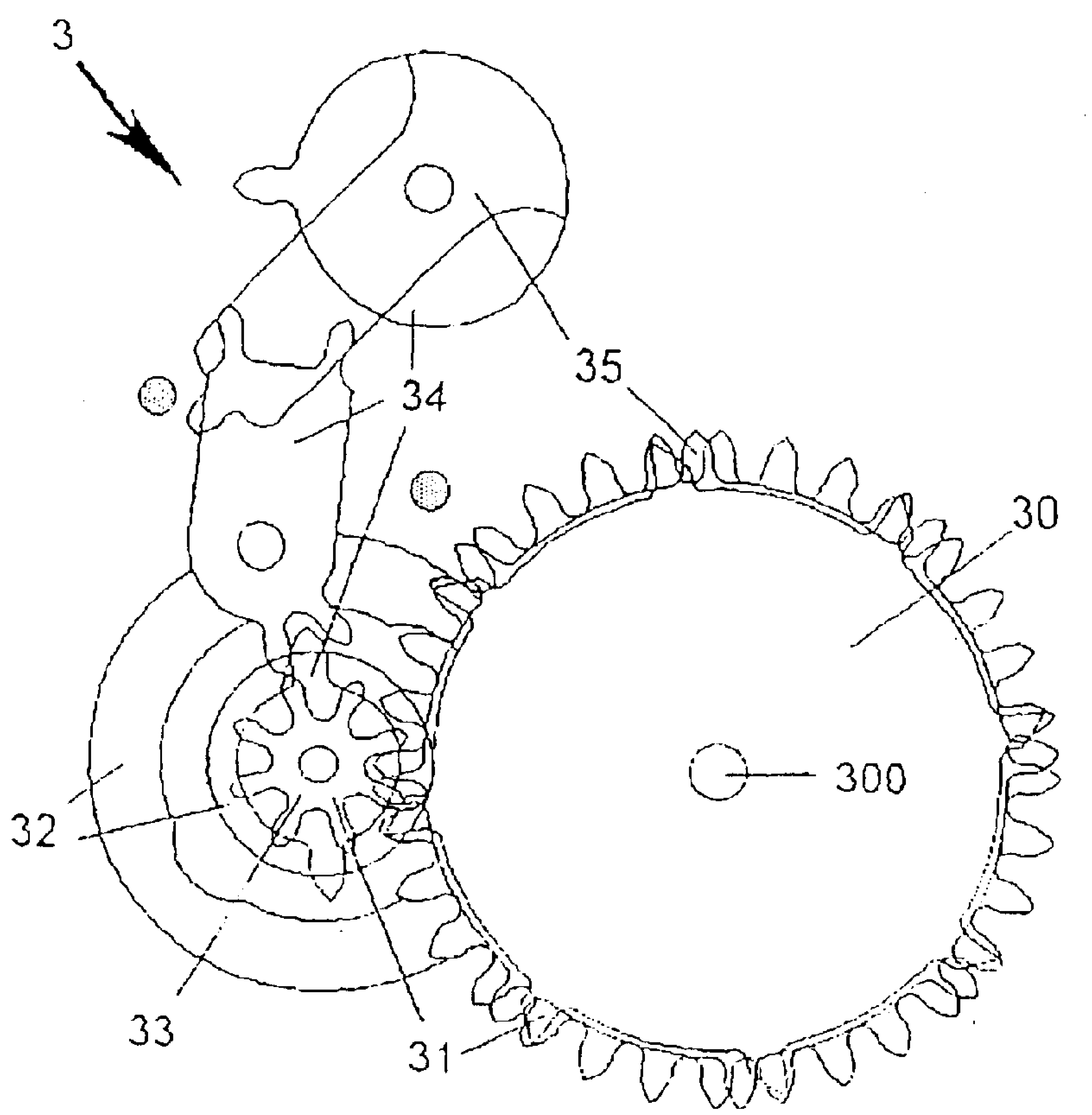


Fig 12

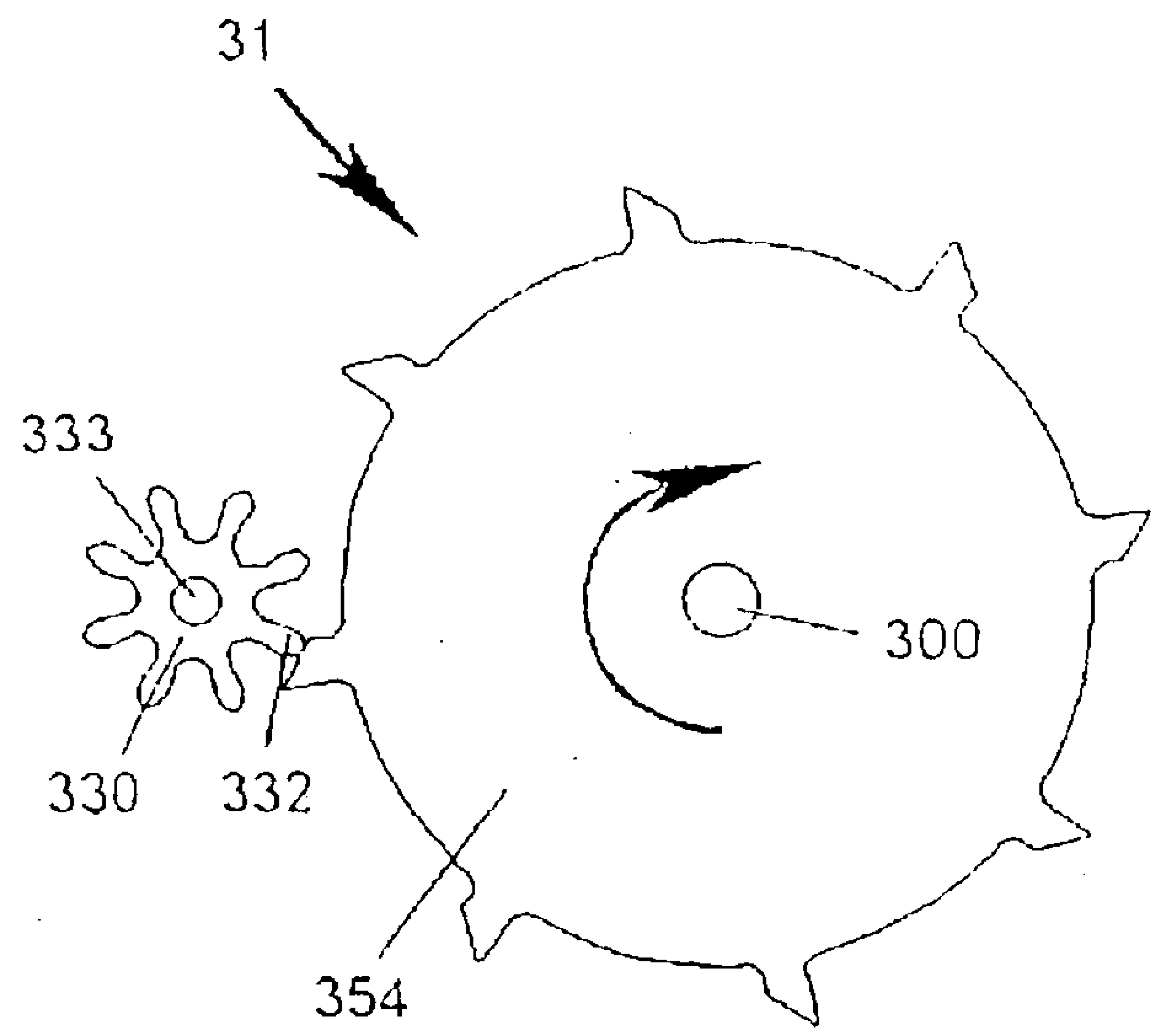


Fig 13

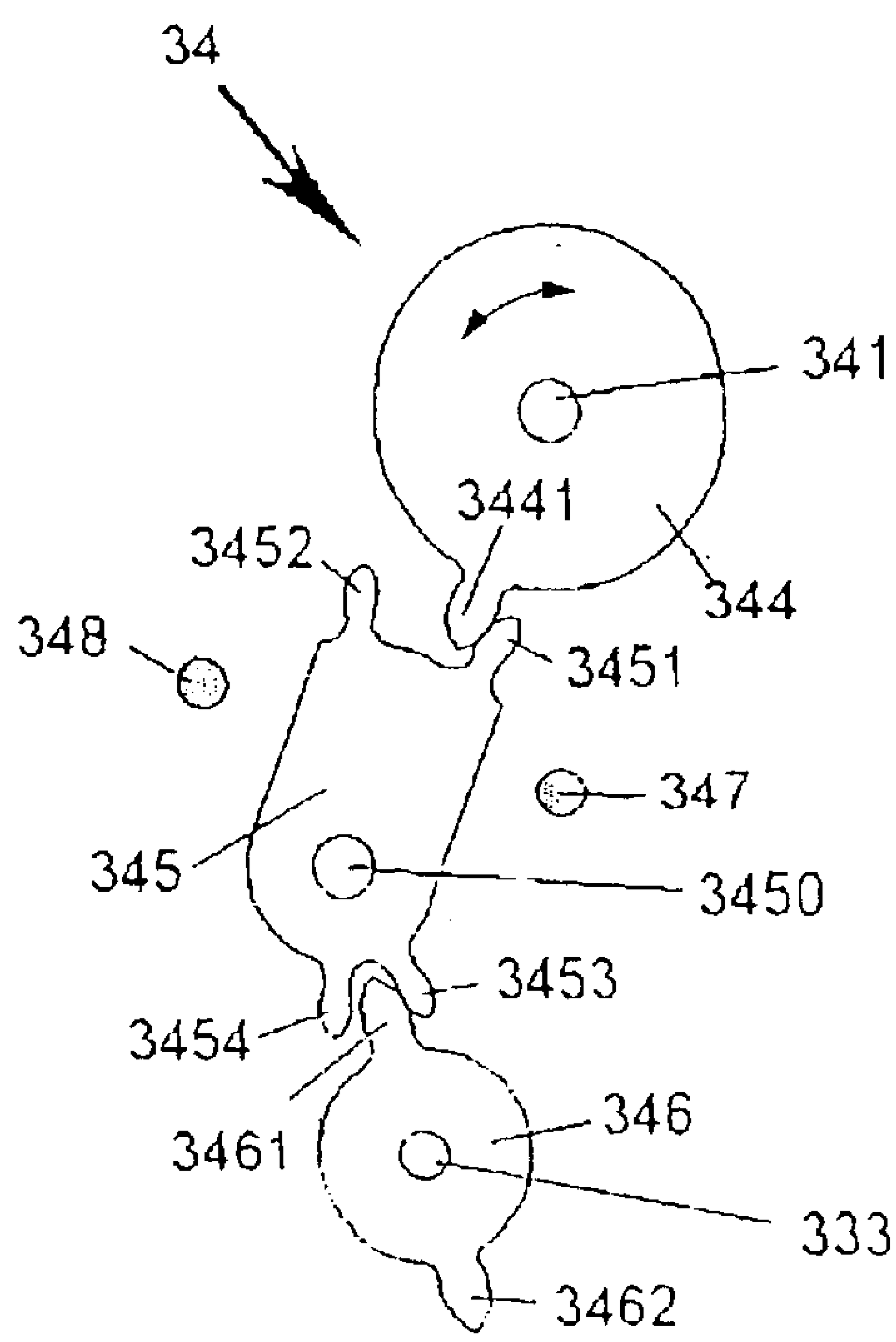


Fig 14

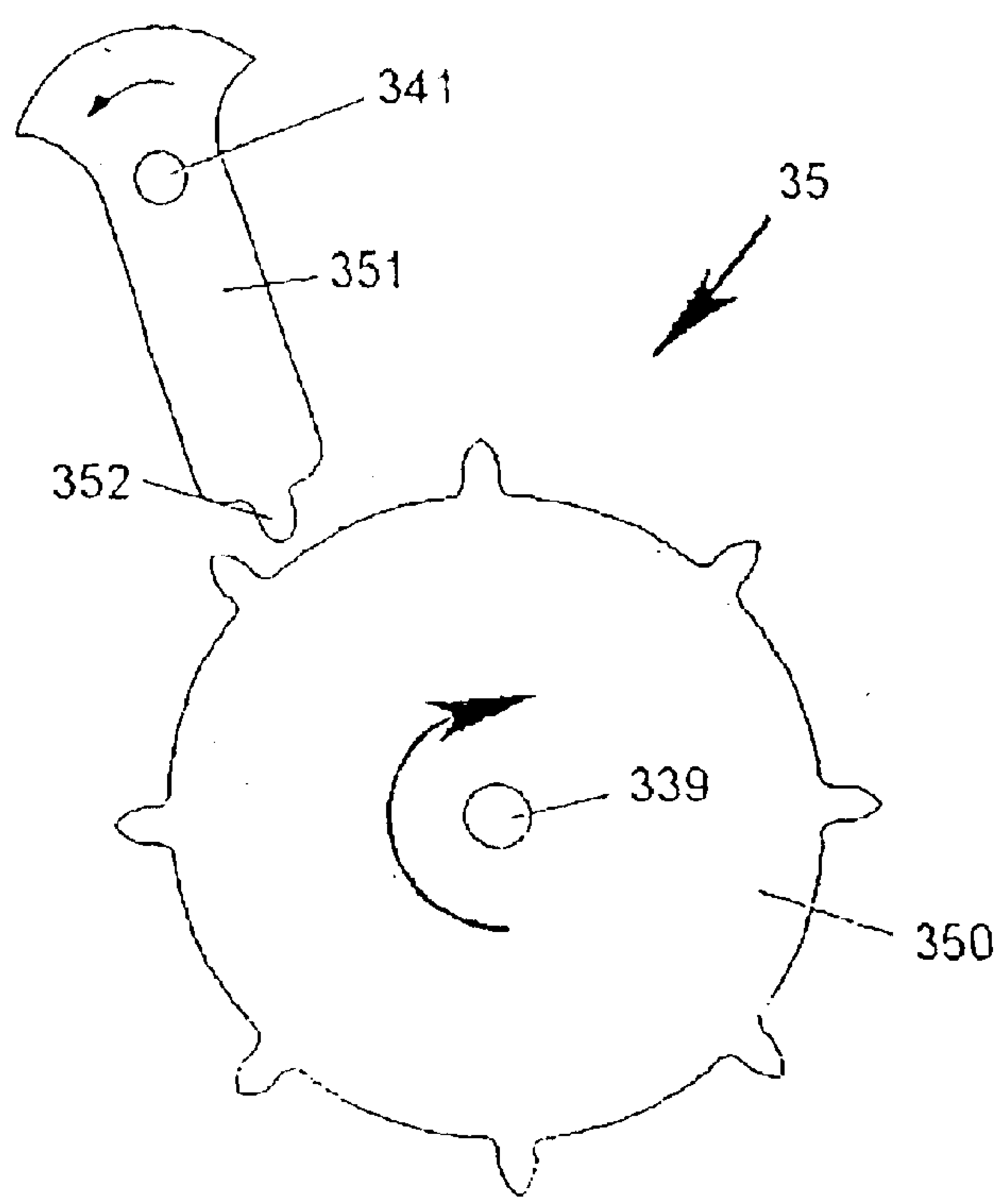


Fig 15

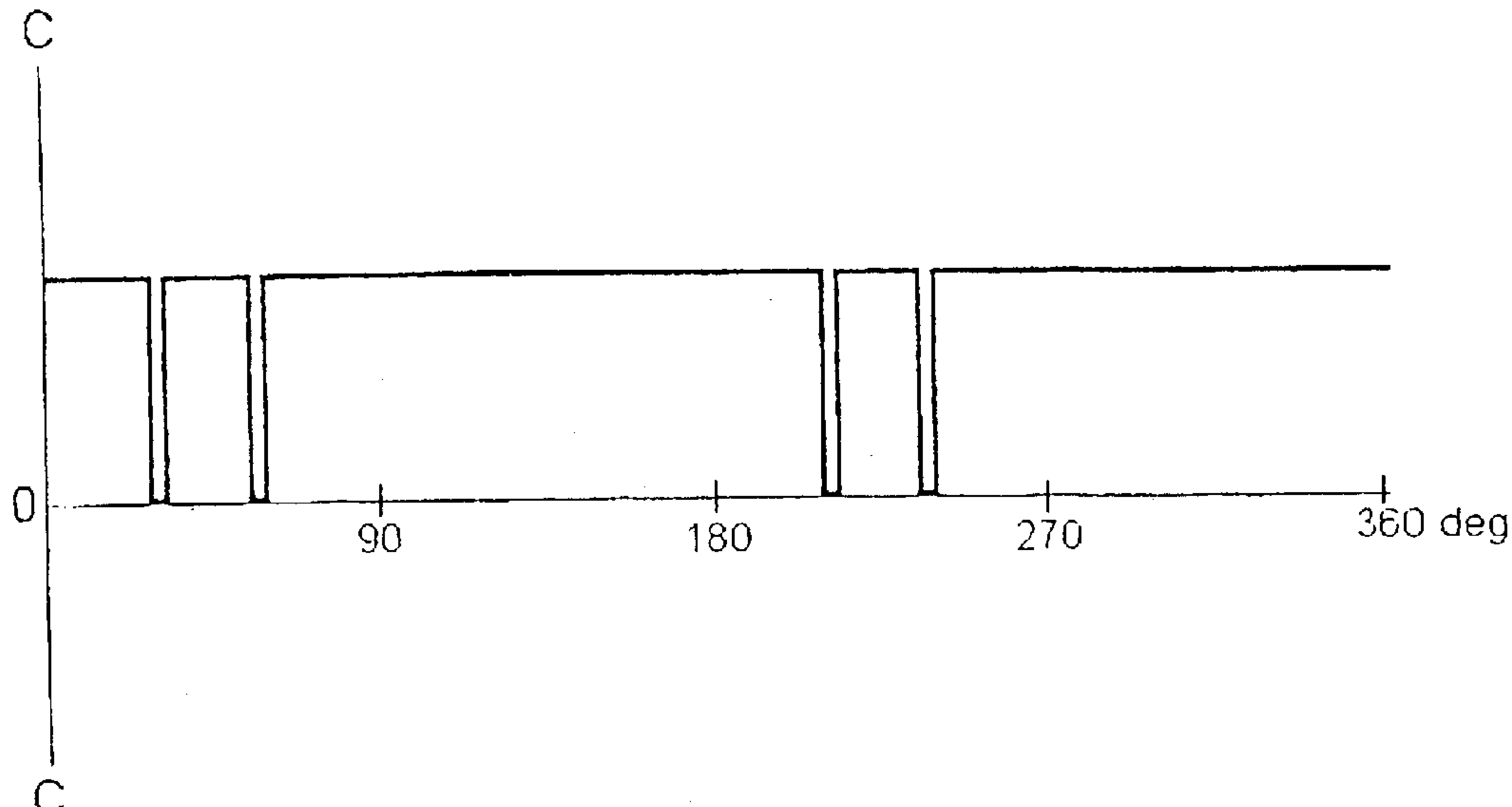

C
0
90
180
270
360 deg.
C

Fig 16

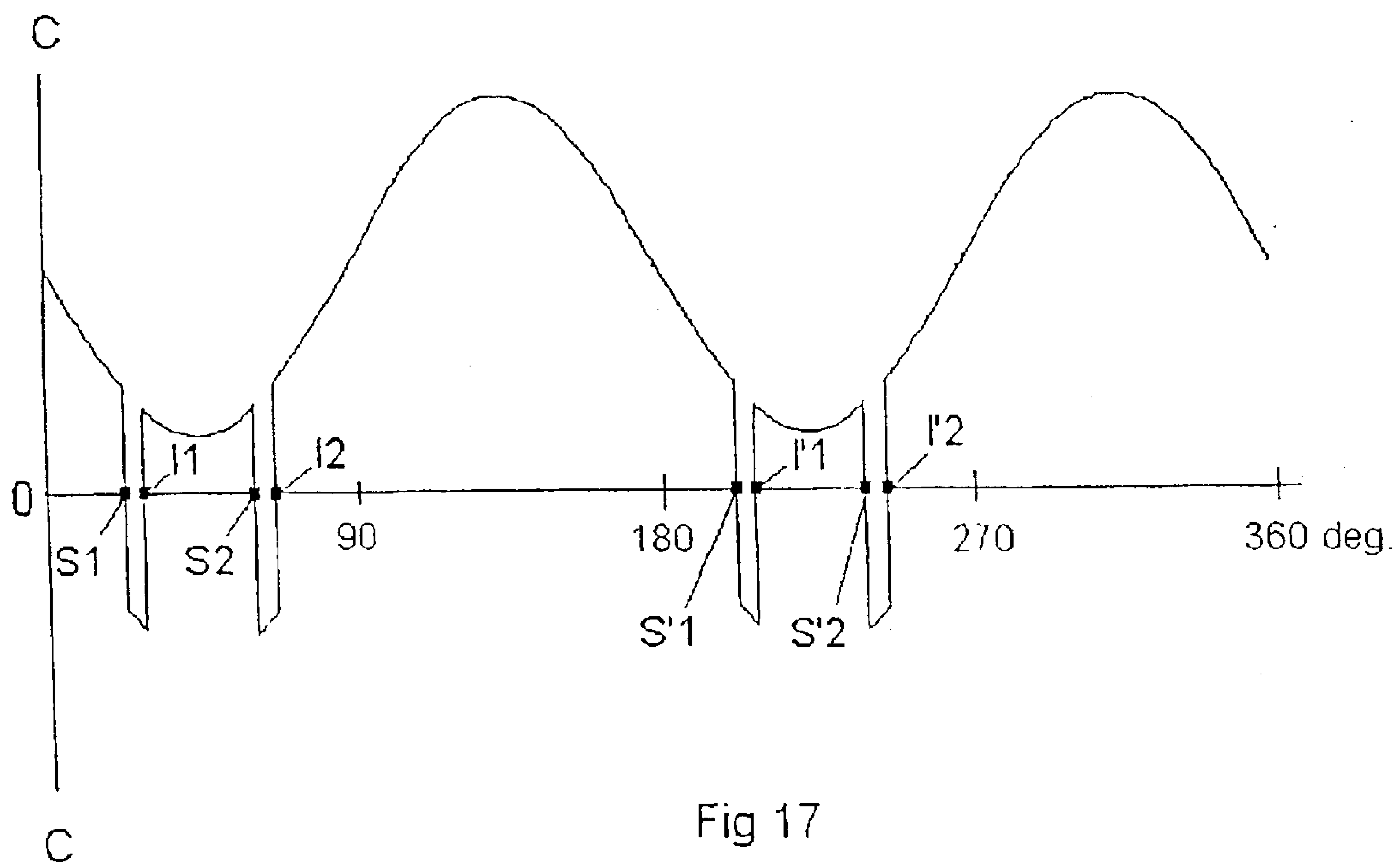

C
I1
I2
I'1
I'2
0
S1
S2
90
180
270
360 deg.
S'1
S'2
C

Fig 17

ESCAPEMENT DEVICE FOR TIMEPIECE

BACKGROUND OF THE INVENTION

The present invention concerns an escapement device for a timepiece.

For a timepiece and particularly a mechanical timepiece, the escapement device constitutes a master part which, on one hand, has to deliver the power required to maintain the oscillatory motion of the mechanical oscillator, balance wheel, and hairspring, and on the other hand, must transmit the oscillation frequency of the oscillator to the gears driving the time display.

PRIOR ART

Thus, the prior art in devices of this type is considerable. The handbooks published under the titles "Echappements et moteurs pas à pas" (Escapements and step motors) and "Théorie d'horlogerie" (Watch-making theory), ISBN 2-940025-10-X, both by the Swiss Federation of Technical Colleges, describe numerous escapement devices, and in particular those called "anchor", "detent", and "Graham" escapements.

The major drawbacks of these known devices are:

- a poor efficiency; the best efficiency that can be obtained with these known devices is of the order of 30 to 40%, which limits the running time of the watch,
- a limited working frequency; the efficiency of the known escapements drops off considerably when the oscillator frequency is raised to a perceptible degree, and moreover, anchor escapements develop a wear problem of the escapement wheel when the frequency is high,
- difficulties of manufacture; for efficiencies of the order of 30 to 40%, the anchor escapements require a number of highly precise trimming operations.

SUMMARY OF THE INVENTION

It is a goal of the present invention, therefore, to propose an escapement device for a timepiece that is improved over known devices, that is, their known drawbacks have been reduced at least in part.

It is another goal of the invention to propose an escapement device that is insensitive to external impacts, and will not exhibit galloping effects.

It is yet another goal of the invention to propose a timepiece equipped with such an escapement device.

These goals are attained by an escapement device for timepieces as described in claim 1, as well as by a timepiece as described in claim 19. Particular embodiments or variants are described in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the invention will become apparent in the following detailed description, to be read while referring to the attached drawing comprising the figures where:

FIG. **1** presents a functional diagram of a mechanical watch,

FIG. **2** presents a first embodiment of an escapement device according to the invention,

FIG. **3** presents particulars of a blocking device in the escapement device of the preceding figure,

FIG. **4** presents a graph of the mechanical torque transmitted,

FIG. **5** presents a first embodiment of means to produce a variable torque,

FIG. **6** presents a graph of the magnetic torque transmitted,

FIG. **7** presents intermediate transmission means,

FIG. **8** presents the means of release,

FIG. **9** presents the means of power transmission,

FIG. **10** presents a graph of the resulting torque,

FIG. **11** presents a second embodiment of the means to produce a variable torque,

FIG. **12** presents a second embodiment of an escapement device according to the invention,

FIG. **13** presents particulars of the blocking device in the escapement device of FIG. **12**,

FIG. **14** presents the means of release in the escapement device of FIG. **12**,

FIG. **15** presents the means of power transmission of the escapement device of FIG. **12**,

FIG. **16** presents another graph of the mechanical torque transmitted, and

FIG. **17** presents another graph of the magnetic torque transmitted.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In certain figures among those mentioned above, and described in detail herein-below, certain superimposed parts are represented as if they were transparent, which was done for a better understanding of their interactions.

FIG. **1** presents a functional diagram of a mechanical watch in which the mechanical energy that comes from a winding device, which is manual or automatic, is stored in a mainspring **1** so as to be distributed via a set of gears **2** to an escapement device **3** and to a display **4**.

The escapement device **3** has the purpose, on one hand to deliver the power required to sustain the oscillations of oscillator **5**, which in a general manner comprises a helical spring and an inertial mass, and on the other hand, to transmit the frequency given off by this oscillator to gears **2** in order to synchronize the time display with this frequency.

A good escapement device should not only have a good transmission efficiency between the power source and the oscillator but should also preserve the isochronism of the oscillator. To this end the inertias associated with the escapement device should be minimized and the power transfer between the escapement device and the oscillator should occur within a very short time while the velocity of the oscillator is largest.

FIG. **2** shows a first embodiment of an escapement device **3** according to the invention, comprising: a transmission wheel **30** driven by the set of gears **2** seen above, blocking means **31**, means for the generation of a magnetic torque **32**, intermediate means of power transmission **33**, unblocking means **34**, and power transmission means **35**. These different means will be described in greater detail hereinbelow.

FIG. **3** shows the transmission wheel **30** as well as the blocking means **31**. The transmission wheel **30** is set in rotation by the mainspring **1** via the gears **2**, and is driven by a mechanical torque of essentially constant value. The shaft **300** holding the transmission wheel **30** transmits the forward movement to the display device **4**. The blocking means **31** consist here of a shaped part or cam **310** mounted on the same shaft **333** as a pinion **330** that is part of the intermediate means of transmission shown in greater detail in FIG. **7**, as well as of bolts **311** fastened to the transmission wheel **30** so as to protrude perpendicularly to the plane of said transmission wheel. The bolts **311** are regularly distributed over a perimeter of said transmission wheel. In the example of an embodiment presented, the transmission wheel **30** has ten bolts **311**, but depending on the requirements it could have a different number of bolts.

The shape and dimensions of the cam **310** as well as the diameter of the bolts **311** and of the perimeter along which they are inserted, are determined in such a way that, when the cam **310** which rotates together with the pinion **330** that is driven by the transmission wheel **30**, is turned with one or the other of its long sides **312** to the transmission wheel **30**, the transmission of torque can occur directly from the wheel **30** to the pinion **330**. To the contrary, when one of the short sides **313** arrives in front of a bolt **311**, blocking of this short side **313** of cam **310** on the bolt **311** occurs and the transmitted torque is interrupted.

FIG. **4** shows the mechanical torque transmitted to the shaft **333** that holds the pinion **330**, plotted as a function of the angle of rotation of said pinion. At first the curve shows a torque of constant value until the cam **310** arrives in the blocking position marked A_I in the figure, where the transmitted torque becomes zero. Means of unblocking which will be described below then allow the device to become unblocked so that once again the torque of constant value can be transmitted until the next blocking occurs, marked at A_2, and so forth.

The blocking means **31** here described give rise to two blocking positions, A_1 and A_2, per turn of the pinion **330**, but they could just as well be conceived so as to give rise to a different number of blocking positions.

FIG. **5** shows a preferential embodiment of means allowing a torque to be obtained that varies as a function of the angle of rotation of pinion **330**. In this embodiment these means **32** are of a magnetic type, comprising a stator **320** and a rotor **321** that is arranged inside of said stator. The stator **320** consists of a ring of soft ferromagnetic material having along its inner perimeter two cavities **322** that are diametrically opposite to each other. The rotor **321** consists of a permanent magnet of cylindrical shape having a diametrical magnetization represented by the arrow in the drawing. The rotor **321** is mounted on the same shaft **333** as the pinion **330** and the cam **310** that have been described previously.

When the rotor **321** is set in rotation, the cavities **322** give rise to a magnetic torque acting on said rotor that is an essentially sinusoidal function, as can be seen in FIG. **6**. When the rotor **321** is oriented so that its axis of magnetization is parallel to the axis C—C in FIG. **5** or perpendicular to the axis B—B containing the two cavities **322**, then the rotor **321** is in a stable equilibrium position, in which a slight angular displacement will tend to return the rotor toward this stable position, but when the same rotor is oriented so that its axis of magnetization is parallel to the axis B—B, it is in an unstable equilibrium position, which means that a slight angular displacement will tend to remove the rotor even further from this unstable position. The stable angular positions are marked S in the curve of FIG. **6**, they correspond to a zero crossing of the curve with a negative slope of the torque, while the unstable angular positions are marked **1** in the same curve, and correspond to a zero crossing of the curve with a positive slope of the torque.

It should be noted here that the frequency of the curve representing the torque is twice that of rotation of the magnet or of pinion **330**, which is so because of the stator/rotor configuration described. With another configuration one could have a multiple other than two between these two frequencies.

The intermediate means of transmission **33** presented in FIG. **7** essentially comprise the pinion **330** already seen above, as well as a second transmission wheel **331** mounted on a shaft **339**. We recall that the shaft **333** holding the pinion **330** also holds the cam **310** as well as the rotor **321**. The intermediate means of transmission **33** allow the different torques coming into play in the device to be combined.

The release means **34** of FIG. **8** are of known construction. The release pallet **340** is integral with the oscillator (that is not presented in the figure), and oscillates about the shaft **341**. During its oscillatory motion in the counterclockwise direction, the tooth of pallet **340** encounters a tooth of the escapement wheel **342**, and imparts to it an impulse of torque in the clockwise direction. As the escapement wheel **342** is mounted on the same shaft **339** as the second transmission wheel **331** seen above, this impulse of torque is therefore transmitted from this transmission wheel **331** to the pinion **330**. By appropriate fixation of the escapement wheel **342** on the transmission wheel **331**, viz., in such a way that the impulse of torque be transmitted just after blocking of the pinion **330** by the blocking device described previously, the impulse of torque in a counterclockwise direction that is transmitted to the pinion **330** will release the cam **310** from its blocking position on the bolt **311**, allowing the transmission wheel **30** to perform part of a revolution until the next blocking occurs. The time display **4** has thus advanced by a time segment corresponding to one movement of pallet **340**.

FIG. **9** shows means **35** of power transmission to the oscillator which are of classical design, consisting of a transmission wheel **350** fixed on the same shaft **339** as the wheel **331** and the escapement wheel **342**, and of a shaped part **351** that is mounted on the shaft **341** seen above and attached to the balance wheel of the hairspring (not shown). When the wheel **350** turns clockwise as indicated, and one of its teeth encounters the short side **352** of the shaped part **351** that is moving more slowly counterclockwise, the wheel **350** will furnish kinetic energy to the part **351** or to the hairspring, thus allowing the oscillatory motion of the oscillator to be sustained.

As indicated, the release means **34** and the means **35** of power transmission are of known design, and are here described as examples for a realization; other devices performing the same functions may thus be foreseen as a replacement.

The resulting torque on pinion **330** which consists of the essentially constant torque transmitted by the wheel **30** and shown in FIG. **4**, and of the variable torque transmitted by the magnetic stator/rotor group and shown in FIG. **6**, is shown in FIG. **10**.

In the example shown for this first embodiment of an escapement device, this torque comprises two stable positions per turn of the pinion **330** which are marked S_1 and S_2 in the figure, and correspond to the two blocking positions in FIG. **4**. These two stable positions S_1 and S_2 are defined as previously by a zero crossing of the curve of torque with negative slope. The torque also comprises two unstable positions per turn of the pinion **330** which are marked I_1 and I_2 and correspond to the two unblocking positions in FIG. **4**. These two unstable positions I_1 and I_2 are defined as previously by a zero crossing of the curve of torque with positive slope.

One notices that the resulting torque is always positive, except in the blocking positions where it is negative.

In FIG. **11** a second way is shown of how to obtain a variable mechanical torque having two stable points and two unstable points per turn of the wheel. A cam **323** is fixed on the same shaft **333** as the pinion **330** seen above; this cam has two concave portions and two convex portions. A spring lever **324** pivoting around one of its ends rests via a small wheel **325** on the periphery of cam **323**. The resulting torque of this device is a variable function with two stable points while the small wheel **325** is aligned with the axis C—C, and two unstable points while it is aligned with the axis B—B.

It can thus be seen that several possibilities exist to obtain a variable mechanical torque having at least one stable point and one unstable point.

FIG. **10** shows the mechanical torque acting on the shaft **333** of pinion **330** in the absence of contact with the oscillator, plotted as a function of the angle of rotation of said pinion, now one can describe in parallel the functioning of the device as a function of time.

After a first rotation the device arrives in a blocking position as described with reference to FIG. **3**, and corresponding to the point S_1 in FIG. **10**. The device remains in this position for a time T_1.

When the pinion **330** receives the unblocking impulse, as described with reference to FIG. **8**, it changes from position S_1 to position I_2 in FIG. **10**, the transition being accomplished within a very short time called T_2 and being less than one thousandth of a second. This time must be as short as possible in order to cause minimum perturbation of the oscillator.

Starting with this position the resulting torque, which becomes positive, furnishes to the oscillator via the power transmission means described the energy that is required by the oscillator during a time T_3 which is of the order of a few thousandths of a second, lasting until the next blocking position S_2 is attained.

A mechanical oscillator generally has an oscillation frequency of a few hertz, typically 4 Hz. For this frequency the period T that corresponds to the sum $T_1+T_2+T_3$ is 250 ms. In view of the low values reported above for T_2 and T_3, the value of T_1 will then be just a few milliseconds smaller than that of T. It follows that the device is in a blocking position during the largest part of time T.

While a timepiece equipped with an escapement device such as that described above would satisfy the requirements indicated, such an escapement device when built into a wristwatch could be subject to a galloping effect.

In fact, in a wrist watch not subject to perturbations from outside, the amplitude of balance wheel oscillation in the clockwise direction is of the order of +240° relative to the axis that passes through the centers of rotation, and of the order of −240° in the opposite direction. Under these conditions the escapement wheel **30** advances one step in the clockwise direction in each balance wheel oscillation.

During an impact having a component in the plane of rotation of the escapement device, additional energy is transmitted to the oscillator via the inertia of the balance wheel, the result being that the amplitude of oscillation of the balance wheel may increase to a value higher than 360°. Under these conditions the unblocking means **34** in an escapement device such as that presented in FIG. **2** provide more than one impulse per oscillation period, which provokes a fast advance of the watch here called galloping.

FIG. **12** presents another embodiment of an escapement device **3** according to the invention with which the drawback mentioned above can be avoided. This embodiment of the escapement device comprises as previously a transmission wheel **30** driven by the set of gears **2** (cf. FIG. **1**), blocking means **31**, means for the generation of a magnetic torque **32**, intermediate transmission means **33**, unblocking means **34**, and power transmission means **35**, the description of these different means being given hereafter.

The blocking means **31** of the escapement device of FIG. **12** can be seen in FIG. **13**, they consist of a toothed wheel **354** that cooperates with the pinion **330**. Here the teethed wheel **354** has eight teeth of asymmetric shape, is mounted on the same axle **300**, and pivots together with the transmission wheel **30** seen above.

In the position called rest position shown in FIG. **13**, the end of tooth **332** of the pinion **330** rests against the straight flank of an asymmetric tooth of the wheel **354**.

When a torque is applied to the axis **300** of wheel **354** in the direction of the arrow, it exerts a force going through the center of rotation of shaft **333** of the pinion **330**. For this reason no torque is transmitted to the pinion, and this set of wheel and pinion remains blocked, a situation which persists until unblocking occurs by the unblocking means described below.

The unblocking means **34** of this embodiment can be seen in FIG. **14**. The release pallet **344** is integrated into the oscillator (not shown in the figure) and oscillates about the shaft **341**. During its oscillatory motion, the tooth **3441** of pallet **344** encounters either the tooth **3451** or the tooth **3452** of an intermediate part **345**, depending on whether the pallet **344** turns counterclockwise or clockwise. The oscillatory motion of the intermediate part **345** about the axis **3450** is limited by bolts **347** and **348**. The unblocking impulse coming from the balance wheel is transmitted to the pallet **346** that is mounted on the same axle **333** and pivots together with the pinion **330** seen above, which currently is blocked. This transmission of impulse actually occurs via the teeth **3454** and **3455** of the intermediate part **345** to one of the teeth, **3461** or **3462**, of the pallet **346**, and acts so as to unlock the set of wheel **300** and pinion **330** of FIG. **13**, so that pinion **330** now can freely rotate.

FIG. **15** shows another embodiment of the power transmission means **35**; these means function in a manner similar to those described with reference to FIG. **9**.

The means for generation of a magnetic torque **32** that varies in time are similar to those described with reference to FIG. **5**.

This embodiment of the escapement device according to FIG. **12** has the advantage over the embodiment of FIG. **2** that in the case of an impact, the amplitude of oscillation of the balance wheel can be limited by bolts **347** and **348**, which thus prevent a loss of synchronization between the movement of the balance wheel and the movement of the wheel **30**, and the gallop mentioned above.

FIG. **16** shows another graph of the torque transmitted by an escapement device. As before, this torque is superimposed on that produced by the magnet in order to obtain the one shown in FIG. **17**.

An escapement device intended to function according to these graphs comprises blocking means having two stable positions in each direction of the oscillatory motion, in other words, four stable positions per period, which is another way of avoiding the galloping mentioned above.

Other embodiments and variants than those described above can yet be envisaged, and more particularly, pinion **330** could be replaced by an anchor performing an oscillatory motion, the arms of the anchor fork bearing two opposing magnets.

Relative to the escapement devices of the prior art, an escapement device according to the invention and according to one or other of the embodiments described in addition offers several marked advantages:

- since the diameters of the rotating parts of the device according to the invention are smaller than those of corresponding parts in known devices, the inertia of said rotating parts is distinctly lower;

the power required for unblocking is lower; moreover, this unblocking is generally not attended by a recoil motion as in known anchor escapements;

thanks to the torque varying according to a curve, which is sinusoidal in the embodiments described, a maximum of torque is available just behind the unblocking position, which implies that the maximum power is transmitted immediately after unblocking, that is, over a limited angle of oscillation of the oscillator, at the moment when this oscillator has its highest velocity; in this way the isochronism of the oscillator is maximally preserved;

the transmission wheels have classical profiles with transmission efficiencies of the order of 90%;

Since certain transmissions of motion occur via gear wheels, greasing is not required as often as with traditional transmissions.

An escapement device as described according to one or the other of its embodiments is readily built into a timepiece, and particularly into a wristwatch, when considering the small diameter of the components of said device.

What is claimed is:

1. An escapement device notably for a timepiece, comprising a mobile organ of power transmission toward an oscillator able to receive said power and of transmitting an oscillation frequency,

a first means able to produce at least a first portion of the power intended to supply the oscillator,

said first means having a configuration such that it will supply a mechanical torque that is essentially variable as a function of the angle of angular displacement of said mobile organ, said mechanical torque having at least one stable position and at least one unstable position during one period of angular displacement of said mobile organ.

2. A device according to claim **1**, including second means able to produce a second portion of the power intended to supply the oscillator, said second means having a configuration such that it will supply a mechanical torque that is essentially constant as a function of the angle of angular displacement of said mobile organ.

3. A device according to claim **2**, including blocking means able to block the power transmission of said second means which are able to produce a second portion of the power intended to supply the oscillator.

4. A device according to claim **3**, wherein the power transmitted to the oscillator by said mobile organ derives from the combination of said first means of power generation and of said second means of power generation, said power transmission being blocked during operation of said blocking means.

5. A device according to claim **4**, wherein the mobile organ of power transmission is a rotating pinion that always transmits a positive mechanical torque, except for moments in time where the torque is between a stable position and an unstable position.

6. A device according to claim **5**, wherein the torque transmitted by said pinion has two stable positions and two unstable positions per turn of said pinion.

7. A device according to claim **5**, wherein the torque transmitted by said pinion has four stable positions and four unstable positions per turn of said pinion.

8. A device according to claim **5**, wherein said first means able to generate at least a first portion of the power intended to supply the oscillator comprises a rotor bearing a magnet which rotates together with said pinion, said rotor being placed into a magnetic circuit.

9. A device according to claim **8**, wherein the magnetic circuit consists of a stator surrounding said rotor, said stator exhibiting at least one asymmetry.

10. A device according to claim **5**, wherein said first means able to generate at least a first portion of the power intended to supply the oscillator comprises a cam exhibiting at least one concave portion and one convex portion and rotating together with said pinion, a lever resting against the periphery of the cam while being pressed against said periphery by an elastic means.

11. A device according to claim **3**, wherein the blocking means has a configuration such that it operates in stable equilibrium points of a curve of transmitted torque.

12. A device according to claim **11**, wherein the blocking means has a configuration such that its operating point in the stable equilibrium points of the curve of transmitted torque is closer to the unstable equilibrium position of the mechanical torque furnished by said first means which are able to generate said first portion of the power intended to supply the oscillator, than to the stable position of the mechanical torque transmitted by the same first means.

13. A device according to claim **12**, wherein the mobile organ is a rotating pinion that always transmits a positive mechanical torque except for moments in time where the torque is between a stable position and an unstable position, the blocking means comprises a cam having at least one peripheral blocking portion, said cam being fixed to said pinion of power transmission for the supply of said oscillator, and a transmission wheel equipped with protruding projections cooperating with said cam in order to block said escapement.

14. A device according to claim **12**, wherein the blocking means comprises said pinion of power transmission for the supply of said oscillator and a toothed wheel exhibiting a number of asymmetric teeth cooperating with said pinion in order to block said escapement.

15. A device according to claim **13**, including an unblocking device able to command resumption of the transmission of power intended to supply the oscillator, said unblocking device having a configuration such that it operates between a stable equilibrium point and an unstable equilibrium point of the curve of transmitted torque.

16. A device according to claim **15**, wherein the unblocking device comprises a release pallet mounted on said oscillator, said release pallet being able to transmit an impulse of torque to an escapement wheel able to retransmit this impulse to said pinion, said impulse being able to unblock said cam blocked by one of said protruding projections.

17. A device according to claim **15**, wherein the blocking means comprises said pinion of power transmission for the supply of said oscillator and a toothed wheel exhibiting a number of asymmetric teeth cooperating with said pinion in order to block said escapement, the unblocking device comprising a release pallet mounted on said oscillator, said release pallet being able to transmit an impulse of torque to an intermediate part mounted so as to pivot oscillating about an axis, said intermediate part being able to retransmit this impulse to another pallet mounted on said pinion which is able to unblock said pinion that is blocked against a tooth of the toothed wheel.

18. A device according to claim **17**, wherein the amplitude of oscillating pivoting of the intermediate part is limited by two bolts.

19. A timepiece equipped with an escapement device according to claim **1**.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,712,500 B2
DATED : March 30, 2004
INVENTOR(S) : Xuan-Mai Tu et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [56], **References Cited**, U.S. PATENT DOCUMENTS, insert:
-- 5,025,428 A 6/1991 Jarochowski --; and insert:
-- OTHER PUBLICATIONS
Echappements et Moteurspas a pas (Excapements and Step Motors), "Les Echappements", Federation des Ecoles Techniques de Suisse FET-Neuchatel"; Charles Huguenin et al.

Theorie d'horlogerie (Watch-Making theory), Federation des Ecoles, Charles-Andre Reymondin et al. --

Column 8,
Line 55, delete "oscillating" and insert -- oscillatingly --.

Signed and Sealed this

Seventh Day of September, 2004

Jon W. Dudas

JON W. DUDAS
Director of the United States Patent and Trademark Office

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Signed and Sealed this

Twenty-third Day of November, 2004

JON W. DUDAS
Director of the United States Patent and Trademark Office